***Efficient Embedded Course***

**LAB 8**

**SERIAL COMMUNICATIONS LAB EXERCISE:**

**PERFORMANCE ANALYSIS**

**Issue 1.0**

Contents

[1 Introduction 1](#_Toc90435372)

[Overview 1](#_Toc90435373)

[2 Details 1](#_Toc90435374)

[2.1 Hardware 1](#_Toc90435375)

[2.2 Software 1](#_Toc90435376)

[2.3 References and Sources 2](#_Toc90435377)

[3 Deliverables 3](#_Toc90435378)

# Introduction

## Overview

In this project you will build a multithreaded application which receives information from a GPS receiver, decodes it, and displays speed and track information on the LCD. You will use a foreground/background scheduling approach.

# Details

## Hardware

GPS receiver modules are available from various sources listed below. There are also smartphone apps available which share the phone’s GPS data with other devices via Bluetooth (which will require a transceiver) or other methods. In addition, there are GPS simulator programs which are useful for testing.

Use an external LCD to display the speed and direction of travel.

## Software

* ISR
  + UART Receive Data Interrupt
    - Receives NMEA-0183 data from GPS receiver (or simulator board).
    - Enqueues messages into queue for decoder.
    - Extra credit: Uses a finite state machine to filter out sentences with invalid checksums and other errors.
* Foreground Task
  + Initialization
    - Initialize hardware and data structures as needed.
  + Loop
    - NMEA-0183 sentence decoder
      * Decode NMEA-0183 sentences of type GPRMC to find position, velocity, track angle, time and date. Note that sentence length may vary depending on whether a satellite fix has been acquired or not. Because of this you can’t assume that a field will always be in the same location. Instead you will need to parse the sentences using field separators (commas).
        + Example sentence with fix: $GPRMC,123519,A,4807.038,N,01131.000,E,022.4,084.4,230394,003.1,W\*6A
        + Example sentence without fix: $GPRMC,123519,V,,,,,,,230394,,\*76
      * Extra Credit: Validate the sentences using the checksum. If sentence is corrupted, increment num\_bad\_sentences. If sentence is valid, increment num\_valid\_sentences.
      * Extra Credit: Prevent data race conditions for the shared data.
    - Update LCD
      * Displays current speed and track angle.
      * Extra Credit: Graphical display with vector.
* Shared Data
  + Input queue for NMEA decoder
  + GPS information
    - Time and date of fix:
      * unsigned long time;
      * unsigned long date;
    - Position
      * Latitude
        + float lat;
      * Longitude
        + float lon;
    - Track
      * float ground\_speed;
      * float track\_angle;

## References and Sources

* NMEA-0183 Protocol
  + <http://en.wikipedia.org/wiki/NMEA_0183>
  + <http://www.gpsinformation.org/dale/nmea.htm>
* Example GPS receiver modules and shields
  + <http://www.junetrading.com/index.php?route=product/product&product_id=72>
  + <https://www.sparkfun.com/search/results?term=GPS&what=products>
  + <https://www.sparkfun.com/products/10709>
  + <https://www.sparkfun.com/products/10710>
  + <http://www.trimble.com/embeddedsystems/>
* Example GPS forwarding apps for smartphones
  + [www.symarctic.com/extgps/](http://www.symarctic.com/extgps/)
  + <http://max.kellermann.name/projects/blue-nmea/>
  + <http://sharedroid.jillybunch.com/user.html>
* Example GPS simulator program with NMEA output
  + <http://www.labsat.co.uk/index.php/en/products/free-satgen-nmea-software.html>
* Example Bluetooth transceivers
  + <https://www.sparkfun.com/categories/115>
* Example Bluetooth shields
  + <http://www.robotshop.com/bluetooth-shield-arduino-slave.html?utm_source=google&utm_medium=base&utm_campaign=jos>

# Deliverables

* Archive of entire project directory, including source code and subdirectories.
* Demonstration of operation.